Air Force
Astronautics Laboratory

Edwards Air Force Base, California

AH 665991

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AF Cryogenic & Fluid Management Spacecraft Technology Program

28 - 30 April 1987

Mr Roy Silver
AFAL/LKDB

Requirements - - - -

OTV

- 10 K Payload to GEO, Mid 1990's
- 15 K Payload to GEO, Late 1990's
- Space Based OTV, Post 2000

Beamed Energy Weapons

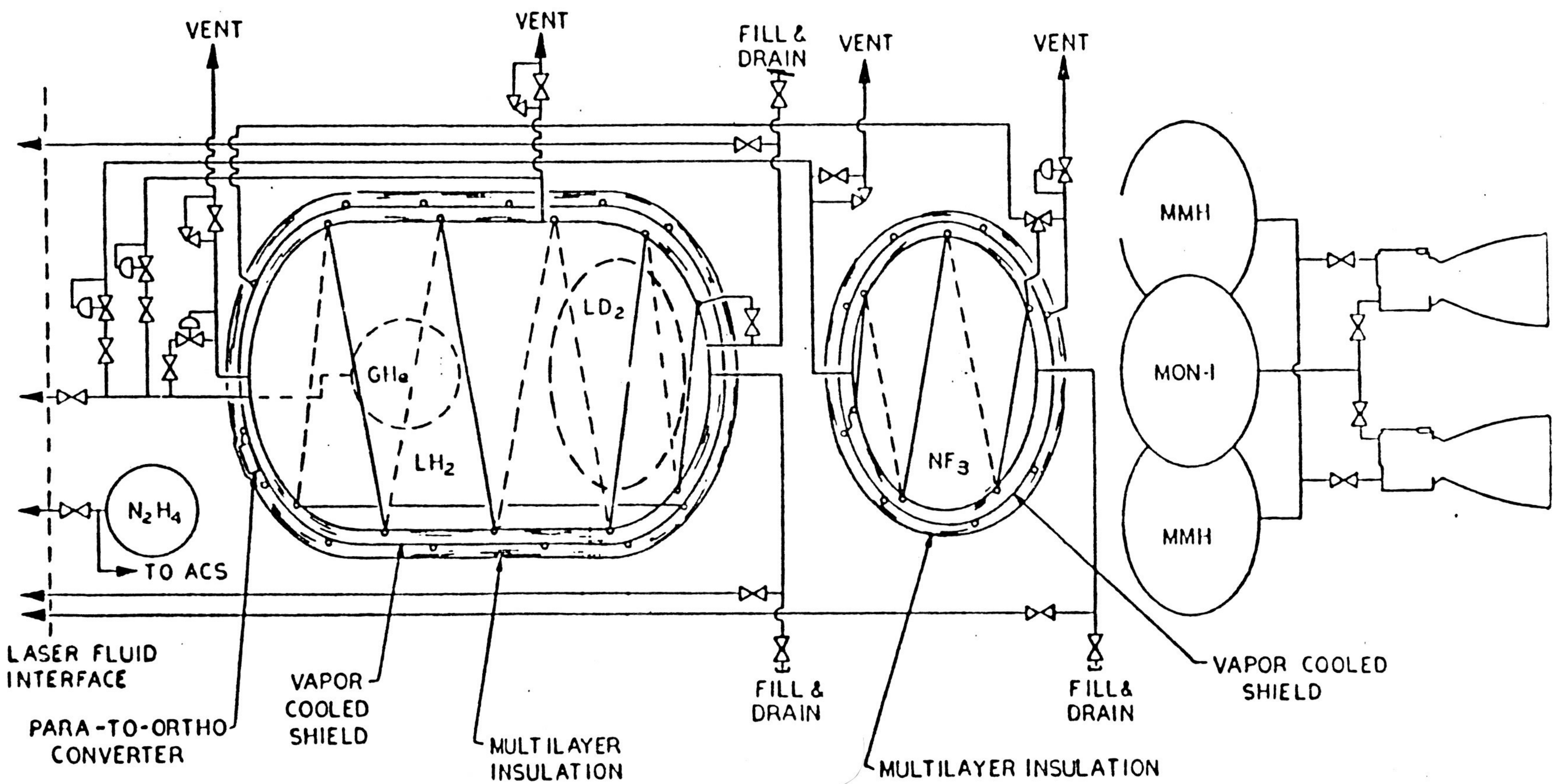
- 20 Year Operational Life
- Laser Reactants / Power Generation

Resupply / Reuse

- Extend Satellite Life
- Prerequisite for Space Weapons

LASER SYSTEM 1 POINT DESIGN

SOA SYSTEM SCHEMATIC



REACTANT STORAGE SYSTEM
STORABLE PROPULSION
COUPLED THERMODYNAMIC VENT

MARTIN MARIETTA

LONG TERM CRYOGENIC STORAGE PROGRAMS

PROGRAM	OBJECTIVES
THERMAL MANAGEMENT TECHNOLOGY	
LOW TEMPERATURE HELIUM CIRCULATOR	LOW PARASITIC, 20K CIRCULATOR
LONG-LIFE PUMPED-LOOP COMPONENTS	ESTABLISH COMPONENT FAILURE RATES
CRYOGENIC THERMAL SWITCH	HIGH TURNDOWN RATIO SWITCH
CRYOGENIC HEAT PIPE THERMAL DIODE	HIGH TURNDOWN RATIO DIODE
TWO-PHASE THERMAL TRANSPORT SYSTEMS	EFFICIENT, LONG-LIFE TRANSPORT SYSTEM
SURVIVABLE EXTERIOR SKIN CONCEPTS	LIGHTWEIGHT, STABLE WALL
FLUID MANAGEMENT TECHNOLOGY	
CONVECTION CONTROL	MINIMIZE FLUID THERMAL GRADIENTS
SLOSH CONTROL	MINIMIZE SYSTEM DISTURBANCES
LIQUID ACQUISITION	DEMONSTRATE LARGE SYSTEM COMPATIBILITY
FEED/PRESSURIZATION SYSTEM	HIGH RESPONSE, LOW THERMAL IMPACT
CRYOGENIC PUMPS	HIGH HEAD, HIGH FLOW SUBMERGED PUMP
EMBEDDED TANKS	DEMO. FABRICATION FOR LARGE TANKS
SYSTEM DEMONSTRATION PROGRAMS	
LOW HEAT LEAK TANK	FULL-SCALE INSULATION PERFORMANCE
THERMODYNAMIC VENT SYSTEM DEMO.	DEMO. LARGE-SCALE TVS CAPABILITY
ACTIVELY REFRIGERATED SYSTEM DEMO.	DEMO. ACTIVE REFRIGERATION INTEGRATION

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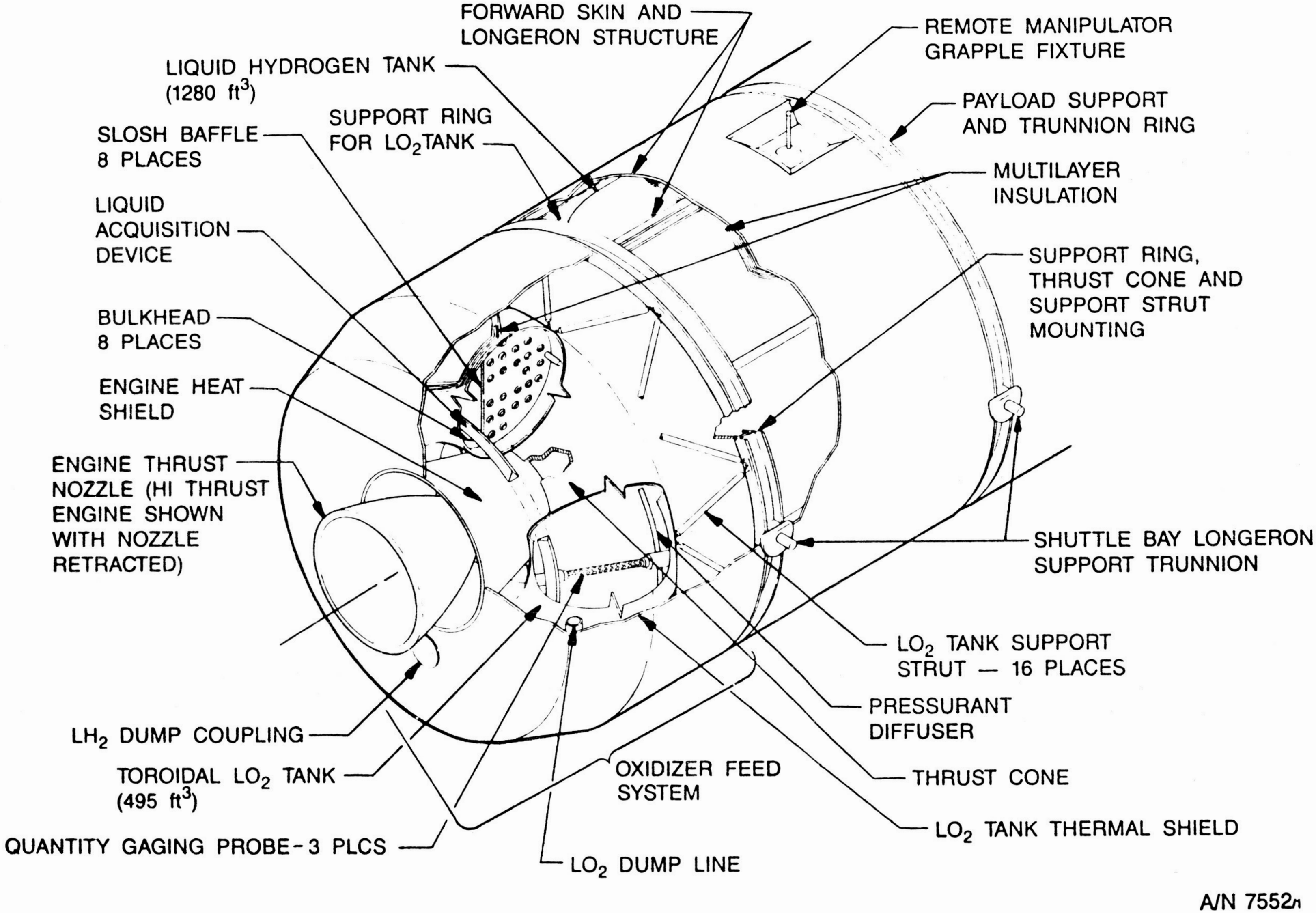
LONG TERM CRYOGENIC STORAGE PROGRAMS

PROGRAM	OBJECTIVES
Thermal Isolation Technology	
Characterization of Thick MLI Blankets	Heat Flux 0.09 W/m^2 Including Seams
Development of MLI/Foam Composite	Demo. Attachment Compatibility with Foam
Supports for Large Cryo. Storage Vessels	4.6×10^{-5} W/K-Strut (LH_2)
Low Conductance Cryogenic Lines	Min. Conductance Large Lines
Open-Cycle Refrigeration Technology	
Para-Ortho Hydrogen Cat. Converter	Conversion.Effic. > 90%
Long-Life TVS Components	Establish Component Failure Rates
Closed-Cycle Refrigeration Technology	
Long-Life 20 K Refrigerator	Seven-Year Machine, Minimim Power Input

ORBIT TRANSFER VEHICLE GENERAL ARRANGEMENT



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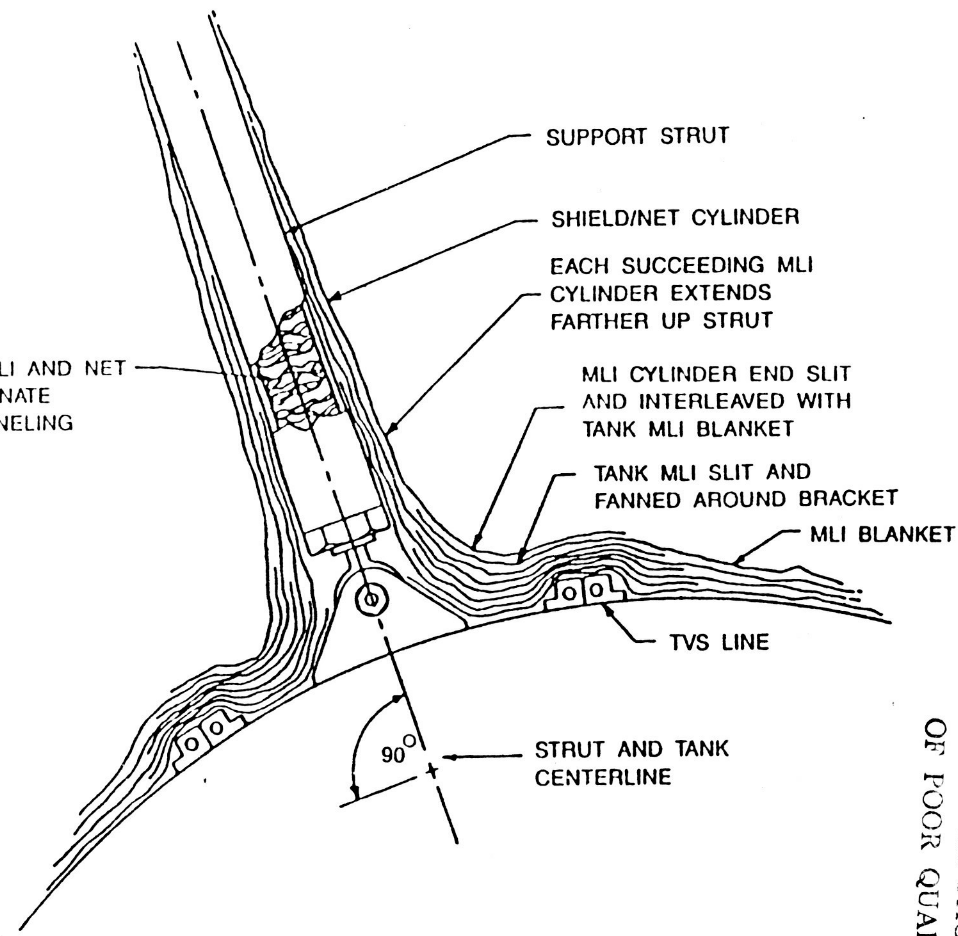
INSULATION PENETRATION DETAIL

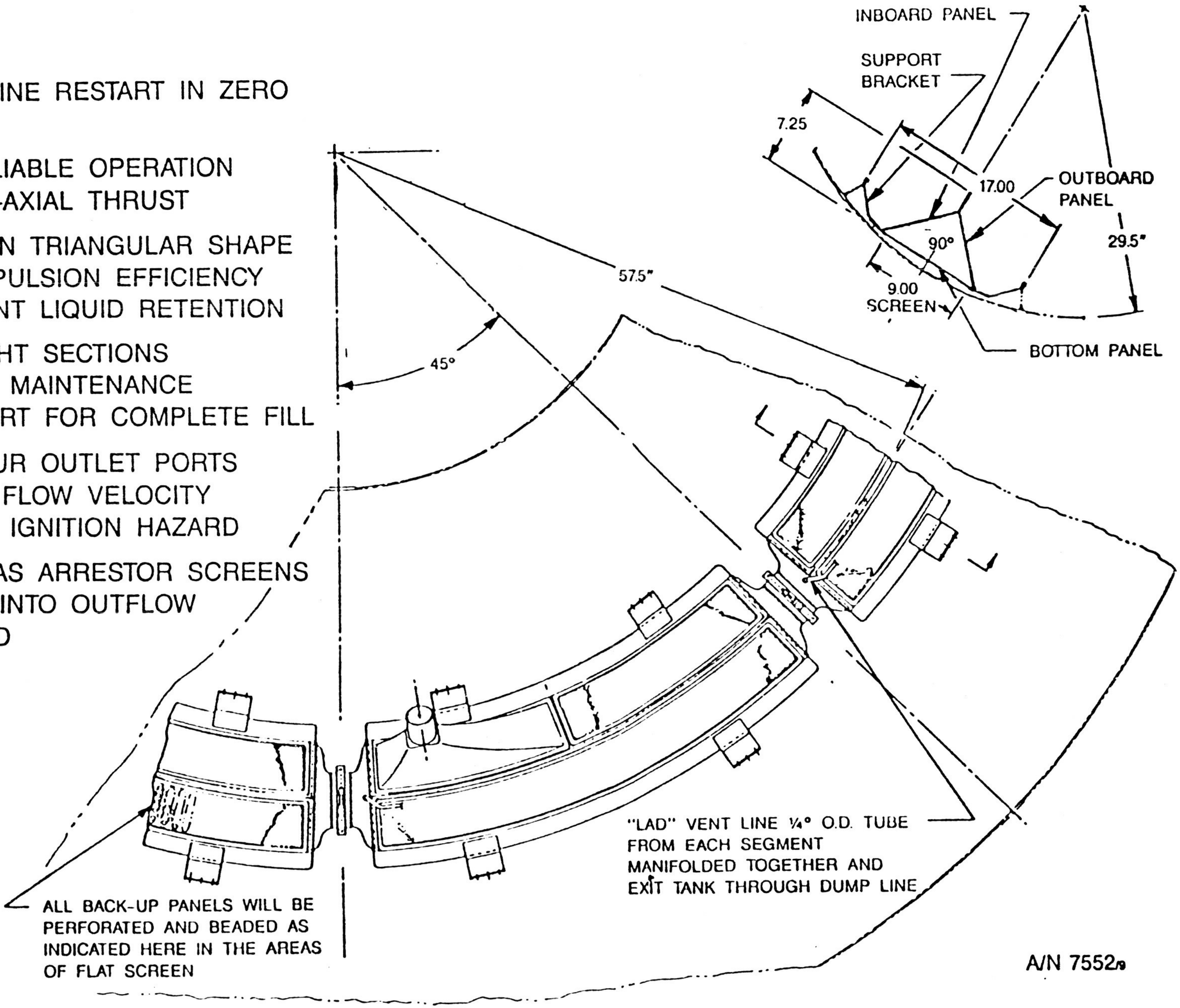
- MLI BLANKET OF DOUBLE ALUMINIZED MYLAR AND DOUBLE DACRON NET
- NO PERFORATIONS
- ONE BLANKET WITH 50 LAYERS OF MYLAR/NET
- MATCHED TEMPERATURE GRADIENT AT PENETRATIONS
- VELCRO STRIPS FOR BLANKET ATTACHMENT TO TANK
- ALUMINIZED TAPE FOR SEAM CLOSURES



A/N 7552/5

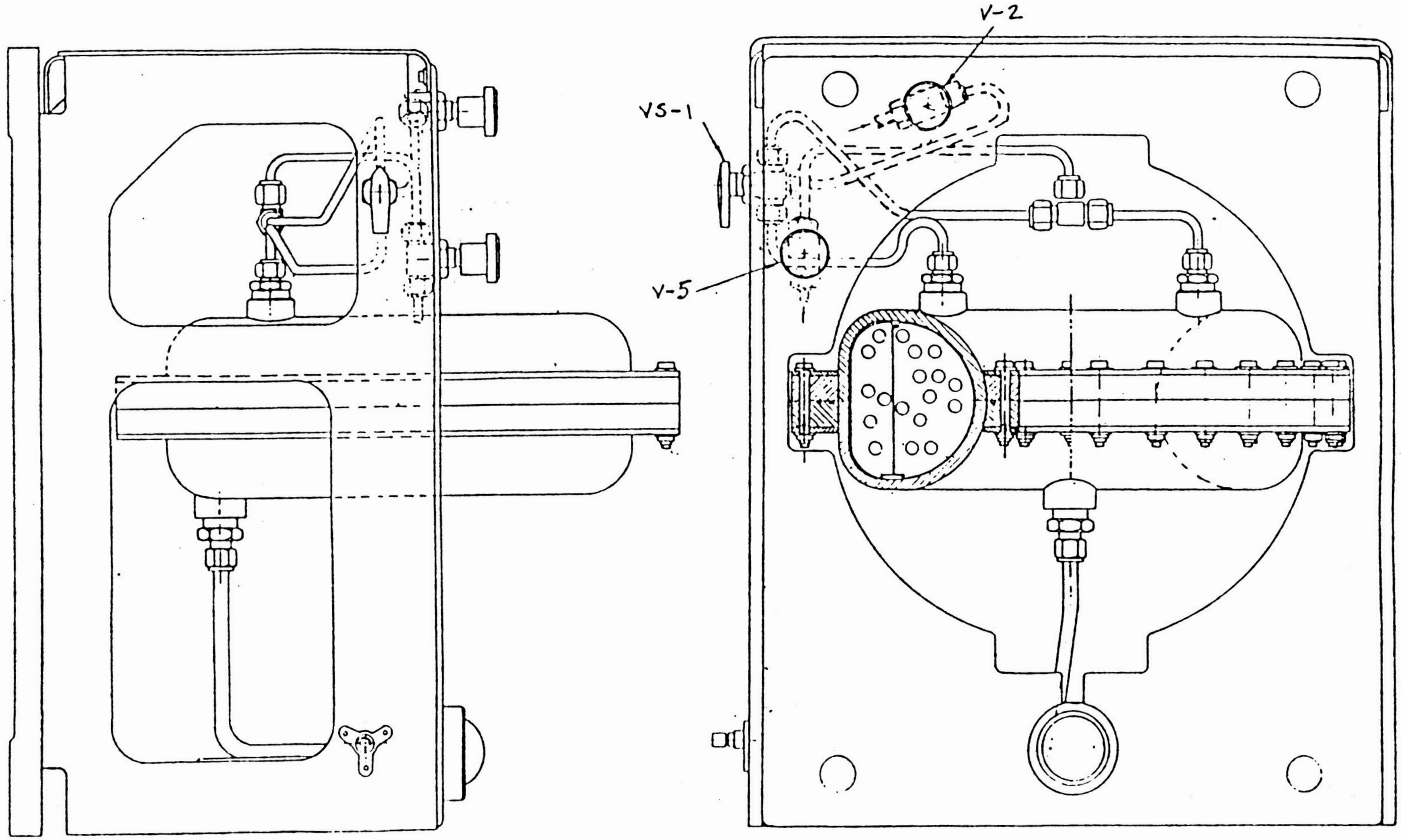
LIQUID ACQUISITION DEVICE (LAD)

- ASSURE ENGINE RESTART IN ZERO GRAVITY
- PROVIDE RELIABLE OPERATION UNDER NON-AXIAL THRUST
- USES PROVEN TRIANGULAR SHAPE
  - — HIGH EXPULSION EFFICIENCY
  - — EXCELLENT LIQUID RETENTION
- BUILT IN EIGHT SECTIONS
  - — EASE OF MAINTENANCE
  - — VENT PORT FOR COMPLETE FILL
- UTILIZES FOUR OUTLET PORTS
  - — REDUCE FLOW VELOCITY
  - — MINIMIZE IGNITION HAZARD
- CONTAINS GAS ARRESTOR SCREENS
  - — NO GAS INTO OUTFLOW MANIFOLD



A/N 7552

SPACE FLUID MANAGEMENT DEMONSTRATION
MIDDECK EXPERIMENT
TOROIDAL TANK

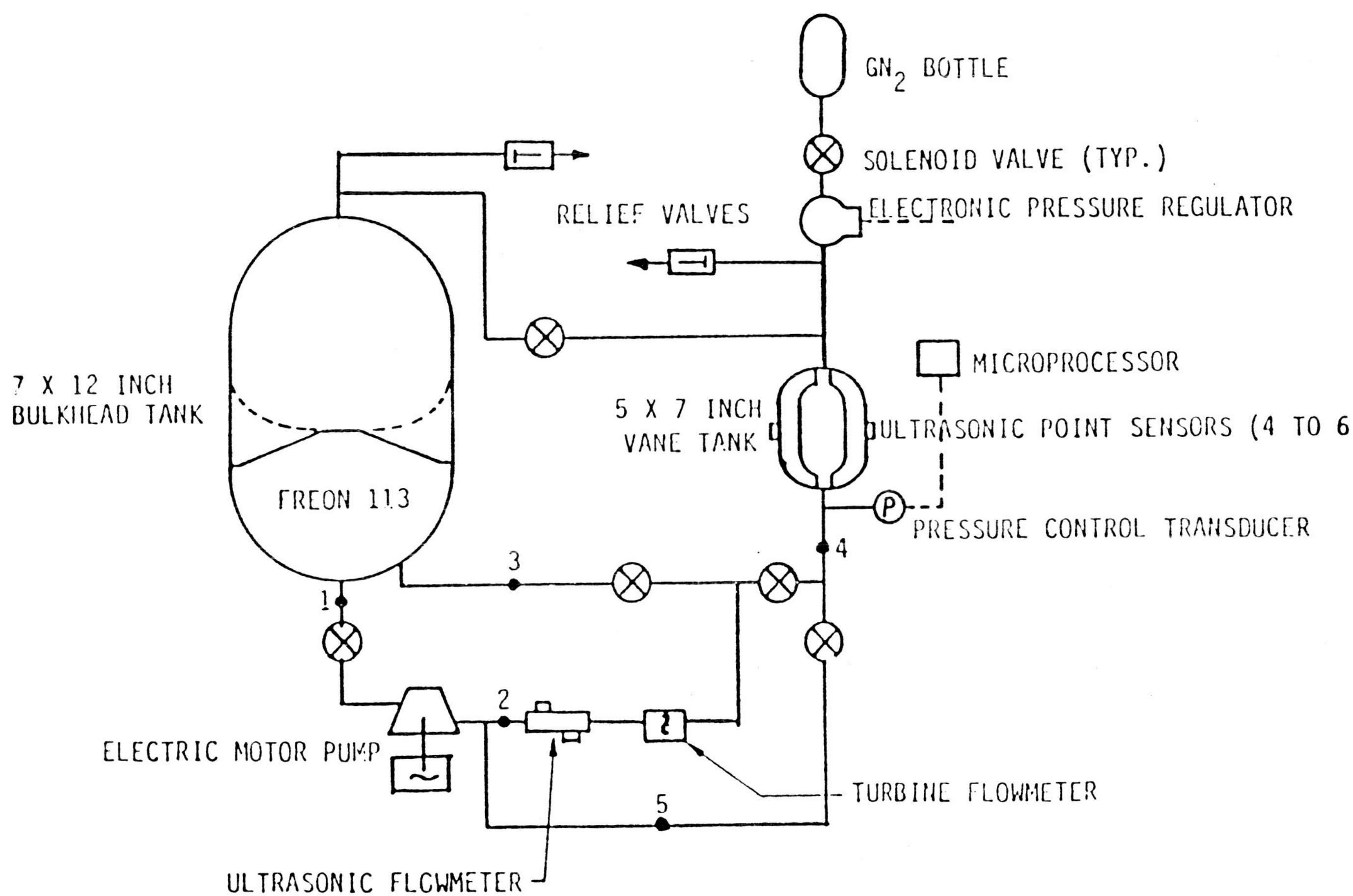


OBJECTIVES:

- LIQUID SETTLING & SLOSH DYNAMICS
- PRESSURIZATION EFFECTS
- FLUID EXPULSION

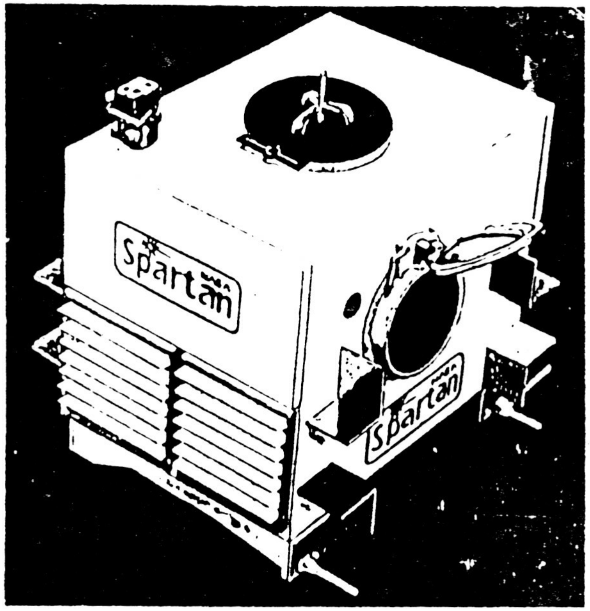
ADVANCED LIQUID FEED EXPERIMENT (ALFE)

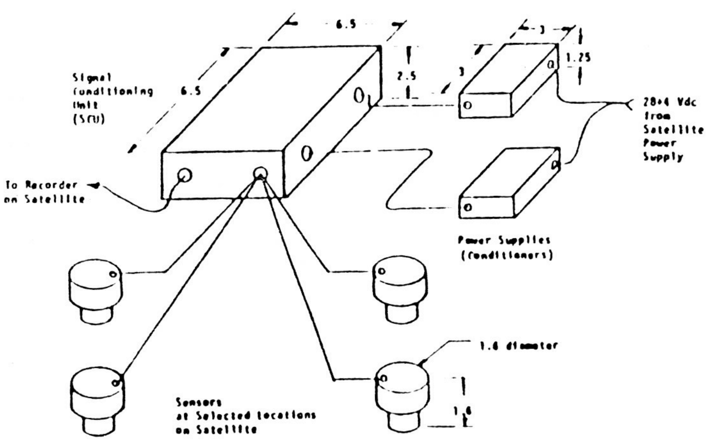
HITCHHIKER EXPERIMENT - SYSTEM SCHEMATIC



AMOSE

Acoustic Measurement On Satellite Experiment





FLIGHT EXPERIMENT COMPONENTS

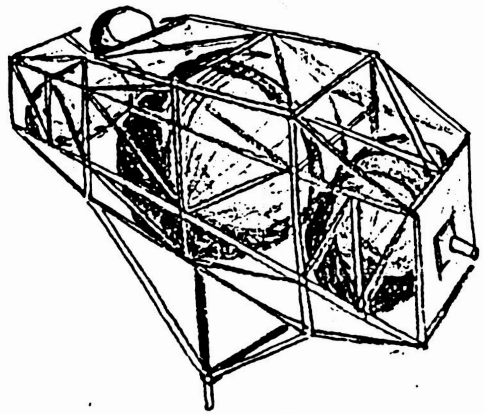
AMOSE OBJECTIVES

MEASURE BACKGROUND NOISE ON A SPARTAN SATELLITE AT ACOUSTICALLY ISOLATED POINTS WITHIN THE SATELLITE.

CURRENT STATUS

* ALL HARDWARE DESIGNED & FABRICATED
* HARDWARE PASSED DYNAMEC, THERMAL VACUUM AND EMI EMISSIVE QUALIFICATION TESTS
* NEW INPUT FILTER REQUIRED TO PASS EMI SUSCEPTABILITY QUALIFICATION TEST
* MANIFESTED FOR SPRING 1992

FLUID MANAGEMENT SPACE EXPERIMENT



APPROACH

* DESIGN/FABRICATE SHUTTLE BAY EXPERIMENT
* FREON TEST FLUID (DATA APPLICABLE TO CRYOGENIC AND STORABLE FLUIDS)
* DEVELOPMENT OF COMPREHENSIVE MODELS
* CONDUCT GROUND VALIDATION TESTS
* CONDUCT THREE FLIGHT TESTS
* VERIFY ANALYTICAL CAPABILITIES

OBJECTIVES / GOALS

* OBTAIN QUANTANTATIVE DATA ON FLUID BEHAVOIR AND CONTROL IN PROPELLANT TANKS UNDER EXTENDED PERIODS OF ZERO/LOW LEVEL ACCELERATIONS.
* DEVELOP AND VALIDATE COMPREHENSIVE ANALYTIC MODELS.

PAYOFFS

* IMPROVED PERFORMANCE
  - INCREASED PAYLOADS
  - REDUCE PROPELLANT REQUIREMENT AND RESIDUALS
  - REDUCED TANK WEIGHT
* REDUCED SYSTEM DEVELOPMENT RISK &DEVELOPMENT TIME
* VALIDATE DESIGN AND ANALYSIS TOOLS
* IMPROVES IN SPACE SERVICING CAPABILITY OF WEAPONS PLATFORM

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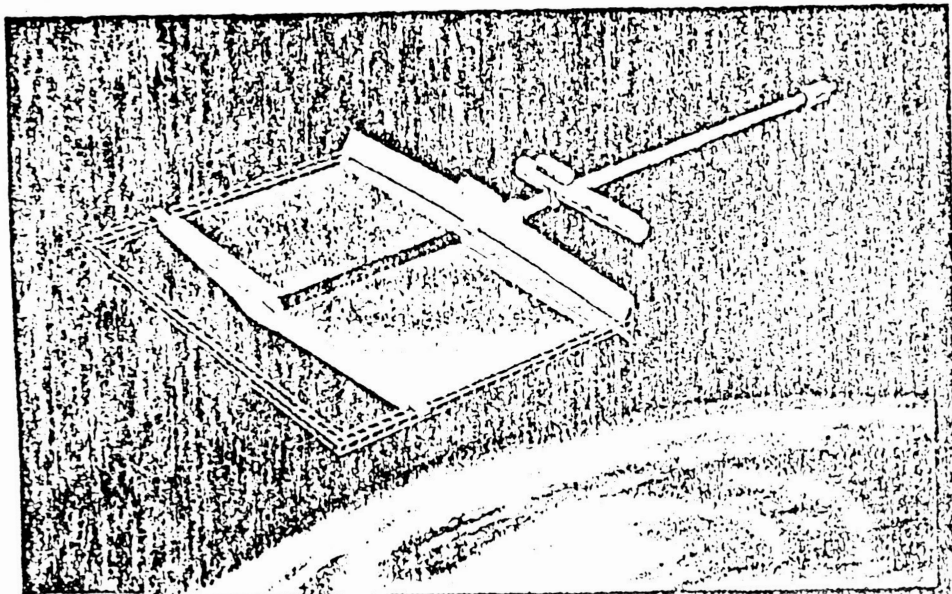
Liquid Droplet Radiator....



TECHNOLOGY/CHALLENGES
- Minimize Fluid Loss in Liquid Droplet Radiators
- Separate Fluids without Gravity
- Develop Zero-Leak Seals for Belt Radiators

OBJECTIVES/GOALS
- Demonstrate Liquid Droplet Radiators in Zero-Gravity
- Demonstrate Feasibility of a Direct Contact Heat Exchanger for Space
- Demonstrate Belt Radiator Concept Feasibility

PAYOFF/MILITARY SIGNIFICANCE
- 75% Reduction in Radiator Weight to Enable High Power Space Systems
- 75% Reduction in Heat Exchanger Weight to Enable High Power Space Systems
- Lower Cost Space Operations

00149

SPEAKER: ROY A. SILVER/AIR FORCE ASTRONAUTICS LABORATORY

E. Patrick Symons/NASA Lewis Research Center:

The three experiments that you talked about; the Mid Deck Experiment with a toroidal tank, the Advanced Liquid Feed Experiment, and the Fluid Management Space Experiment, are those manifested?

Silver:

The SFMD Mid Deck Experiment is in the queue for manifesting. The ALFE is not manifested at this time, but the paper work has just been initiated by the Space Division. We are monitoring that program for the Space Division; it is their program.

Symons:

How about that Fluid Management Space Experiment?

Silver:

The Fluid Management Space Experiment is not currently funded. It is a program which is being submitted through SDI for funding. We have high hopes and plans to proceed with that.

Symons:

Would the structure that you showed as your mounting structure be a unique structure for that experiment the way it is shown?

Silver:

Yes, it would be unique.

Symons:

What is the status on the large diameter tanks that you talked about for the MLI program?

Silver:

Those are part of the contract and will be delivered as part of that program; one of the two tanks will be used for the demonstration of the thick-blanket MLI. It will be laid up on the tank, and then we will be upgrading those tanks with time by incorporating improved struts, incorporating a vapor-cooled shield, and a thermodynamic vent system for the long-term intergrated system demonstration and subsequently incorporating refrigeration systems.